

First Chemical Study of Element 108, Hassium

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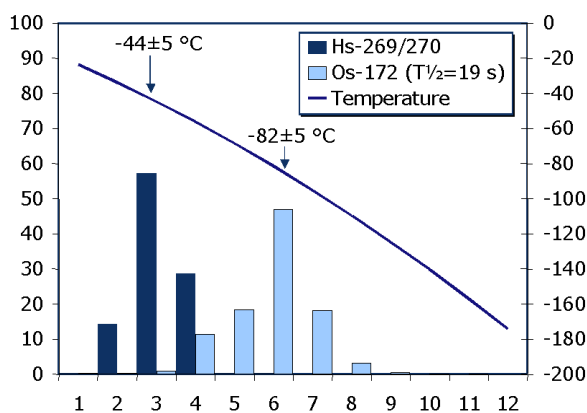
For the first time, a Hs compound has been investigated chemically, thereby extending the Periodic Table to $Z = 108$. During 2001, the Heavy Element Chemistry Group invented the Cryogenic Thermochromatographic Separator¹ (CTS) to study the volatile Group 8 tetroxides. Using the CTS & COLD (Cryo On-Line Detector, a second-generation CTS), we were able to observe the nuclear decay chains from Hs and record the HsO_4 adsorption temperature ($-44 \pm 5^\circ\text{C}$).

The heaviest element studied chemically so far was bohrium (Bh, $Z = 107$) which behaves as a typical Group 7 element². The next heavier element, hassium (Hs) has a relatively long-lived isotope (^{269}Hs , $t_{1/2} = 11.3\text{s}$) that decays by α -emission and was originally identified in the decay chain of $^{277}\text{112}$ ³. Based upon Relativistic Density Functional calculations⁴, HsO_4 is predicted to have a electronic structure similar to its lighter homologue, OsO_4 and thus similar chemical behavior. Additionally, application of different semiempirical models describing the interaction of a MO_4 molecule with a SiO_2 surface predicted similar adsorption behavior of OsO_4 and HsO_4 ⁴.

The operating principle of the CTS (and COLD) is quite simple. After reaction of the Hs with oxygen to form HsO_4 using IVO (In-situ Volatilization and On-line detection)⁶, the volatile tetroxide is then passed through a column formed by a series of parallel PIN-diode detectors (shown at right). Using LN_2 we cooled one end of the detectors and thus established a temperature gradient along the column. Transfer products are either deposited at the entrance if nonvolatile (e.g., ^{211}At), or pass through to the end if volatile (e.g., $^{219,220}\text{Rn}$).

Hs isotopes were produced in the reaction $^{248}\text{Cm}(^{26}\text{Mg}; 5,4\text{n})^{269,270}\text{Hs}$ with cross sections of 6 pb and 4 pb, respectively⁵. In the course of an experiment conducted at the GSI UNILAC data was collected during a 64.2-hour period and a beam

integral of 1.0×10^{18} ^{26}Mg ions. Seven α chains that we attribute to HsO_4 decay were detected at $-44 \pm 5^\circ\text{C}$ that compares with previous work done at LBNL using OsO_4 ($-82 \pm 5^\circ\text{C}$). From these values, we calculate ΔH_{ads} values on silica of $-46 \pm 3 \text{ kJ mol}^{-1}$ for HsO_4 and $-39.5 \pm 1.0 \text{ kJ mol}^{-1}$ for OsO_4 . We conclude that Hs behaves as a typical Group 8 member of the Periodic Table.



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Footnotes and References

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1. U.Kirbach, et al. Nucl. Instrum. Meth. A (in press)
2. R.Eichler et al., Nature **407**, 63 (2000)
3. S.Hofmann et al., Z.Phys. **A354**, 229 (1996)
4. V.Pershina et al., J.Chem.Phys. **115**, 792 (2001)
5. A.Türler et al., P SI 2001 Annual Report
6. Ch.E.Düllmann et al., Nucl. Instrum. Meth. A (in press)